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Conveying Device for Transporting Magnetic Particles,
in particular for Removing Magnetic Filings
from Cooling and/or Lubricating Emulsions

The invention relates to a conveying device for transporting magnetic particles from a first location to a second location, and in particular for transporting magnetic metal filings, entrained in a cooling and/or lubricating emulsion.

Normally, the removal of magnetic particles and, in particular, magnetic filings from a liquid, like a cutting and cooling emulsion, presents problems. If no suitable sieves are available for this removal, then the liquid that has been used once cannot be used again. The renewed use of such a liquid would be important, especially if this liquid were a cooling liquid and/or lubricating liquid and/or lubricating emulsion.

Therefore, the invention is based on the problem of providing a way, in which magnetic particles and, in particular, magnetic metal filings, entrained in a lubricating and/or cooling liquid, can be conveyed from a first location to a second location.

The aforementioned problem, associated with a conveying device of the type described in the introductory part, is solved by the invention in that a tube, which is made of a non-magnetic material, houses a conveying element with magnetic poles, of which the dissimilar poles are

arranged in succession with spacing along at least one helicoidal trajectory in such a manner that they terminate in the vicinity of the inside wall of the tube and allow, as a function of the shape of the trajectory of its arrangement on a rotation of the conveying element relative to the tube, the magnetic particles to be transported along the outside of the tube.

The invention offers the advantage that it allows ferromagnetic particles and, in particular, magnetic metal filings, entrained in a lubricating and/or cooling liquid, to be transported in a relatively easy manner from a first location, like a corresponding holder of a machine tool, to a second location. Therefore, it is made possible to free a cooling and/or lubricating liquid, containing magnetic metal filings, of the ferromagnetic metal filings. Then the respective liquid and/or emulsion can be used over and over again.

According to one practical embodiment of the invention, if at least two trajectories of magnetic poles, which are situated diametrically opposite each other on the conveying element are used, these magnetic poles are formed by the north and/or south pole of a bar magnet. The result is an especially simple construction with the use of a relatively small number of magnetic pole helicoidal trajectories.

According to another practical embodiment of the invention, north and south poles, which are arranged in immediate succession in a defined direction along a magnetic pole helicoidal trajectory, can be formed by the north and/or south pole of a horse shoe magnet. The result is a relatively simple way to provide the conveying device with a relatively large number of magnetic pole helicoidal trajectories.

According to another practical embodiment of the invention, at least two tubes, each one of which contains a conveying element, may be arranged side by side with or without being spaced apart. As a result, a large conveying device for the transport of magnetic particles is achieved in a simple way.

The invention is explained below with reference to the drawings.

Figure 1 is a sectional view of a detail of a conveying device of the invention.

Figure 2 is an enlarged sectional view of the conveying device in Figure 1, using magnets arranged in a single helicoidal trajectory.

Figure 3 is an enlarged sectional view of the conveying device in Figure 1, using bar magnets to form two magnetic pole helicoidal trajectories.

The conveying device, shown in Figure 1, consists, in essence, of a non-magnetic tube 1, which holds a conveying element 2, which in this case also contains a tube 2. Therefore, the one end of the tube 1 is attached to a drive motor 12. A drive shaft 11 of the motor 12 is held stationarily by a flange piece 10, which is rigidly inserted into the tube 2, which is part of the conveying element 2. The other end of the tube 1 is sealed by a flange 14, in which there is only one aperture for holding a pin 13, which is provided on the end opposite the aforementioned end of the tube 2. In this way the tube 2, forming the conveying element 2, can rotate inside the tube 1. This rotation is caused by the motor 12 by means of the drive shaft 11.

In the tube 2, the north and south poles 3 of the corresponding magnets are arranged in alternating order along a helicoidal trajectory. Figure 1 shows such a helicoidal trajectory. However, it is possible, as stated above, to provide a plurality of such helicoidal trajectories and/or north and south poles, arranged in alternating order along such trajectories. If, in this case, the tube 2, carrying the magnetic poles 3, is rotated at a sufficiently high speed in the tube 1, then the magnetic particles, which cling to the outside of the tube 1 along the respective magnetic pole curved trajectory in the region of the individual magnetic poles 3, will migrate along the respective curved trajectory. If, in this case, the magnetic poles 3 are arranged on a left handed helicoidal line, a counter-clockwise rotation of the tube, carrying these magnetic poles 3, causes the magnetic particles to move along the helicoidal trajectory in such a direction that is opposite the direction, along which the respective magnetic poles run in the case of the assumed "left handed" helicoidal trajectory. If the rotational direction is reversed in the arrangement under discussion, then even the magnetic particles are moved in a different direction than before along the helicoidal trajectory. The reason for the transport of the magnetic particles along the helicoidal trajectory can be made plausible if one assumes that, when the tube 2, containing the respective magnetic poles 3, is rotated at a sufficiently

high speed, the magnetic particles, which are held by a magnetic pole 3, cannot follow immediately owing to the friction of the particle's movement on the outside of the tube 1, but rather are easier to attract in the vicinity of a neighboring magnetic pole 3 than by the magnetic pole, to which they were attracted before. In this context, it must be pointed out that for the inclination of the magnetic pole helicoidal line, containing the individual magnetic poles, an inclination of 45º has proven to be especially practical. Then it is desirable to select a spacing of 25 mm between the individual magnetic poles. It must be pointed out that this spacing is a function of both the relative speed between the tubes 1 and 2 and the strength of the magnets that are used.

Furthermore, the configuration in Figure 1 shows a catch basin 16 at the bottom end. With this catch basin, it is possible to move the magnetic particles or rather magnetic filings simply to the outside of the tube 1. Moreover, the use of the respective arrangement for removing magnetic metal filings from a cooling and lubricating emulsion in a machine tool makes it possible to achieve the goal of a better filtering of the respective emulsion. Furthermore, the upper end of the respective conveying device also exhibits now a scraper 17, which enables the magnetic particles, which are transported along the magnetic pole helicoidal trajectory, to be scrapped from the tube 1. In addition to the observed element, Figure 1 also shows a container 18 by means of the dotted-dashed lines. The conveying device is installed in this container. In this case, the conveying arrangement under discussion is supported on its bottom end by a support element 15.

Figure 2 is an enlarged sectional view of the conveying device, according to Figure 1. The individual parts, which are provided in this figure and which correspond to the individual parts, depicted in Figure 1, are marked with the same reference numerals as the individual parts in Figure 1. In this case, a shorter bar magnet 5 is used as the magnet. This bar magnet 5 is penetrated by an anti-magnetic fastening bolt 7, which carries an iron nut part 6 on its end facing the tube 2, and which connects, on its end, facing the tube 2, the bar magnet 5 to the tube 2 by means of an iron nut part 3, which represents simultaneously a magnetic pole 3. In this case there is additionally an iron intermediate plate between the tube 2 and the bar magnet 5. At this point it must also be pointed out with respect to the arrangement that the observed magnet 5 may also be the one magnet leg of a horse shoe magnet, whose other magnet leg is adjacent to the magnet leg, which is currently being

viewed, along the magnetic pole helicoidal trajectory. However, it is also possible to use the respective other magnet leg of the horse shoe magnet for an additional magnetic pole helicoidal trajectory.

Figure 3 is a sectional view of a conveying device of the type, shown in Figure 1, on an enlarged scale. In this case, too, the same elements, which match the elements provided in the arrangement in Figure 1, are marked with the same reference numerals as the matching elements in Figure 1. However, in contrast to the embodiment in Figure 2, a longer bar magnet 9, which extends almost diagonally through the tube 2, serves, in this case, to form the magnetic pole 3. The bar magnet 9 is held by an anti-magnetic fastening bolt 8, which is screwed to the tube 2 by means of suitably formed iron nut parts 3. Thus, an intermediate iron plate is provided between the inside of the tube 2 and the bar magnet 9. This magnetic device makes it possible to form a double helicoidal trajectory or rather a double magnetic screw. In this context ,it must also be pointed out that if the bar magnets 9, which are arranged in succession in the longitudinal direction of the tube 2, are moved by 90° in opposite directions, a four-fold magnetic screw and/or four magnetic pole helicoidal trajectories can be formed in a relatively easy way.

Finally, it must also be pointed out that it is irrelevant for the transport of the magnetic particles on the outer tube 1, whether this outer tube 1 or the inner tube 1 rotates with the magnetic poles 3. The only crucial factor is the relative movement between the two tubes. In addition, the respective conveying device can be used in any position. Hence, not only small and medium-sized magnetic particles, like magnetic metal filings, can be transported along the respective magnetic pole helicoidal trajectory, but also nails, nuts, chain links, screws and similar materials can also be conveyed. Finally it must also be pointed out that the conveying device can be manufactured so as to exhibit almost any length, any diameter according to the building block principle. In addition, it must also be pointed out that a plurality of conveying devices of the type discussed above can be used side by side. In this case, a gap for the outflow of the liquid, containing the magnetic particles, is produced between two adjacent conveying devices. Furthermore, the individual magnetic poles are arranged opposite each other along the magnetic pole helicoidal trajectory with the opposing poles. In this way a strong magnetic field is formed in the respective gap.

Patent Claims

1. Conveying device for transporting magnetic particles from a first location to a second location, and in particular, for removing magnetic metal filings from a cooling and/or lubricating emulsion, containing said magnetic metal filings, characterized in that a tube (1), which is made of a non-magnetic material, houses a conveying element (2) with magnetic poles (3), of which the dissimilar poles are arranged in succession with spacing along at least one helicoidal trajectory in such a manner that they terminate in the vicinity of the inside wall of the tube and allow, as a function of the shape of the trajectory of its arrangement on a rotation of the conveying element (2) relative to the tube (1), the magnetic particles to be transported along the outside of the tube.

2. Conveying device, as claimed in claim 1, characterized in that a north pole and a south pole, which follows said north pole in a defined direction, are formed along the trajectory of the magnetic pole (3) by means of the corresponding magnetic poles (3) of an iron horse shoe magnet.

3. Conveying device, as claimed in claim 1, characterized in that the conveying element (2) carries bar magnets (9), whose ends are located in the vicinity of the inner wall of the non-magnetic tube (1).

4. Conveying device, as claimed in any one of the claims 1 to 3, characterized in that the magnets (5 ; 9) are formed by permanent magnets.

5. Conveying device, as claimed in any one of the claims 1 to 4, characterized in that at least two non-magnetic tubes (1) with the respective conveying element (2), located therein, are arranged side by side.

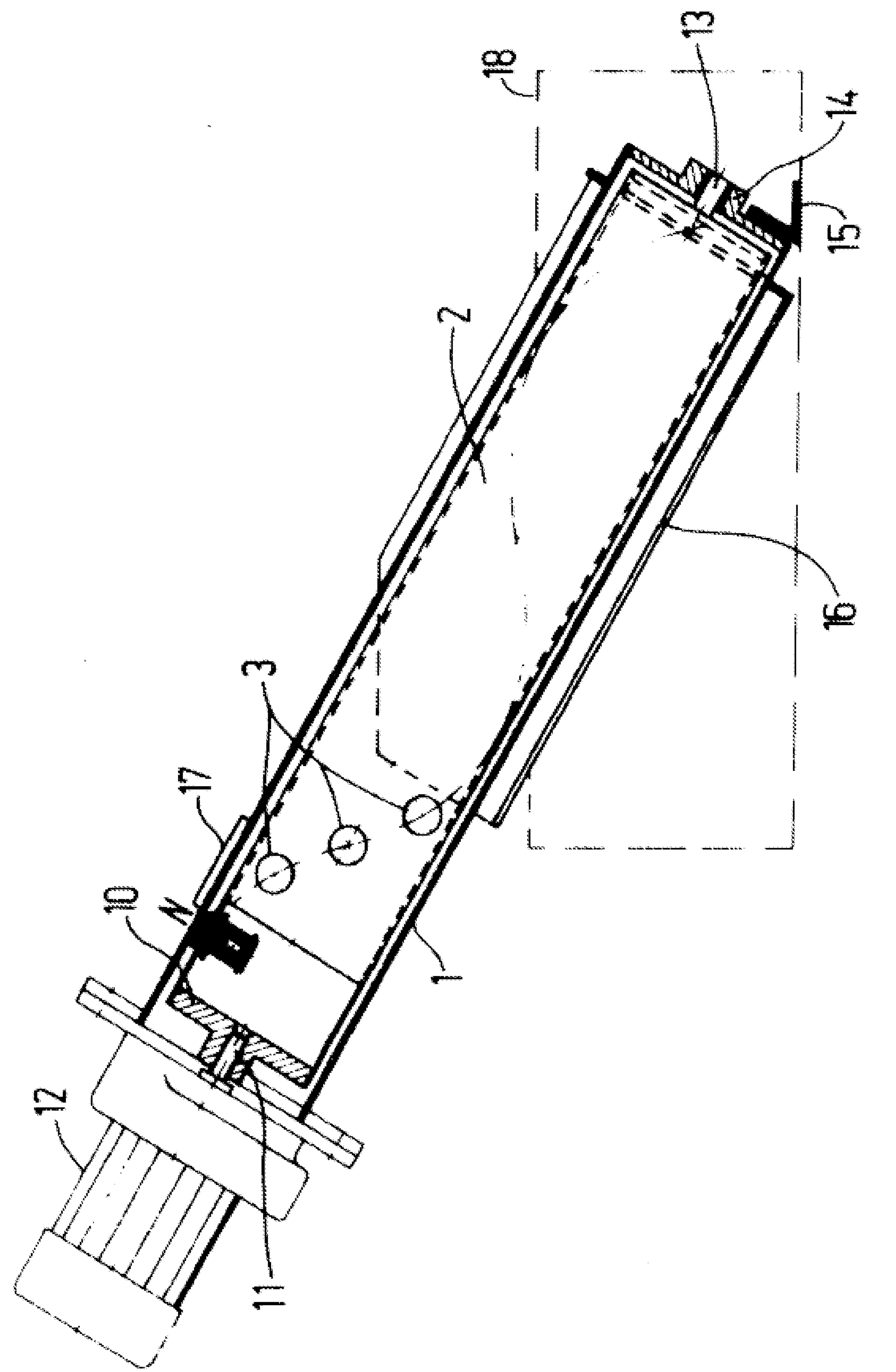

Fig. 1

Fig. 2

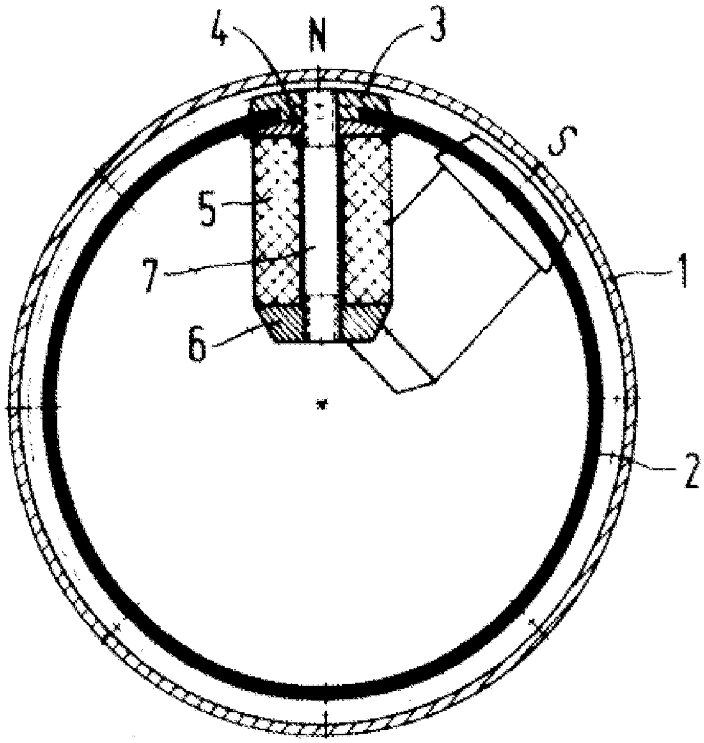

Fig. 3